Closed-loop physics-based manipulation under uncertainty

Completed Technology Project (2017 - 2021)

Project Introduction

Robotic manipulation has wide applications both on Earth and in space. Dexterous manipulators have been carefully designed to assist astronauts with dangerous and time-consuming tasks. Nonprehensile manipulation considers other forms of manipulation besides dexterous manipulation, greatly expanding the number of actions that robots can perform. Planning for nonprehensile motions is particularly interesting because such algorithms can even be deployed on robots that were not designed specifically to perform manipulation tasks. This can endow planetary rovers, such as the KRex rover testbed at NASA Ames, with actions such as pushing and toppling that allow them to actively interact with their environment, in addition to passively exploring it. These interactions could someday be used to prepare for a crew's arrival by clearing rocks or filling holes from a potential base site on the moon or Mars. When planning for these nonprehensile manipulation tasks, robots must be robust to different sources of uncertainty. The initial pose estimate of the object being manipulated will be noisy and the result of taking an action will not be known exactly. Incorporating sensor feedback would enable robots to reliably perform tasks despite this uncertainty. Developing planning algorithms that incorporate sensor feedback to produce efficient and robust nonprehensile motions under uncertainty is the main focus of this proposal.

Anticipated Benefits

Robotic manipulation has wide applications both on Earth and in space. Dexterous manipulators have been carefully designed to assist astronauts with dangerous and time-consuming tasks. Nonprehensile manipulation considers other forms of manipulation besides dexterous manipulation, greatly expanding the number of actions that robots can perform.

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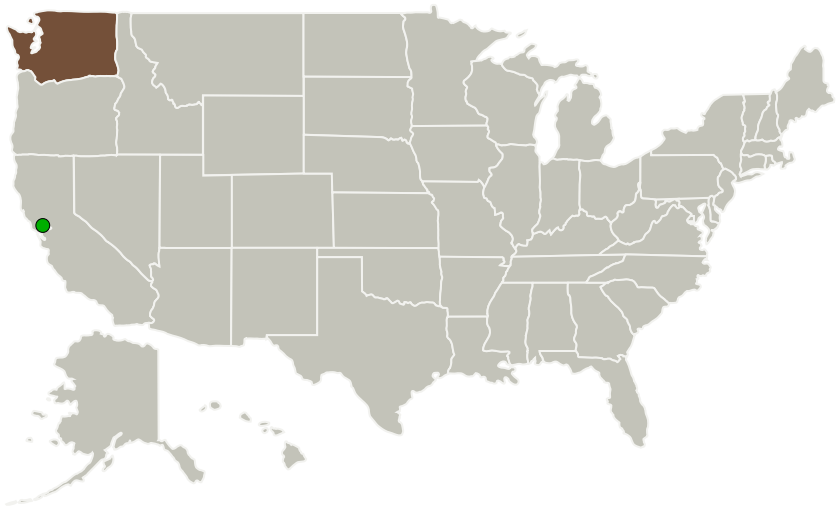
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Washington-Seattle Campus(UW)	Lead Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH), Asian American Native American Pacific Islander (AANAPISI)	Seattle, Washington
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
Washington

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Washington-Seattle Campus (UW)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Siddhartha Srinivasa

Co-Investigator:

Brian Hou

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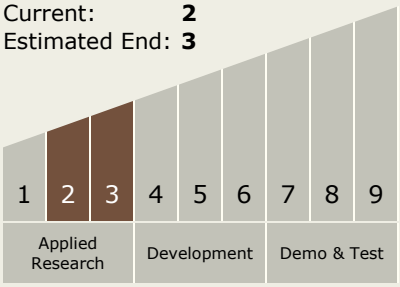
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.3 Manipulation
    - TX04.3.2 Grappling Technologies

Target Destinations

The Moon, Mars, Others Inside the Solar System